UNIVERSITY OF TWENTE.

Formal Methods & Tools.

Model-based Testing with Graph Grammars

Vincent de Bruijn

September 4th, 2012

M.Sc. Colloquium

Model-based Testing (1/3)

- Why testing?

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    - List of requirements

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  - Test if implementation satisfies requirements

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    - Create model from the requirements

Model-based Testing (1/3)

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  - List of requirements
  - Test if implementation satisfies requirements
- Creating tests manually:
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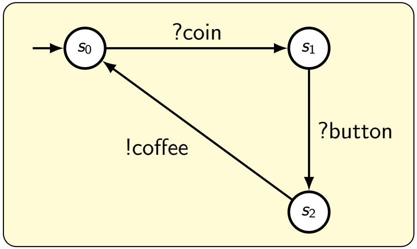
  - Time intensive
- Solution
  - Create model from the requirements
  - Generate tests automatically using model

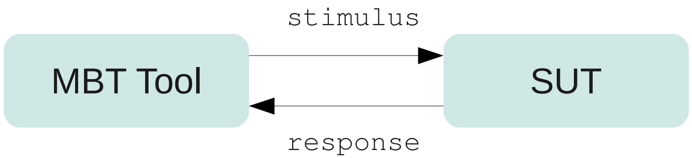
Model-based Testing (2/3)

Model

- An abstract representation of the behavior of a system



Model-based Testing (3/3)



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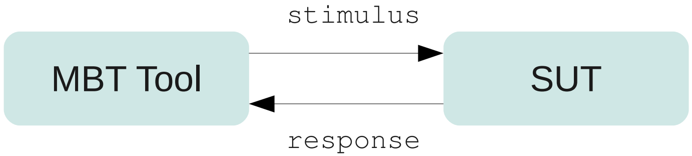

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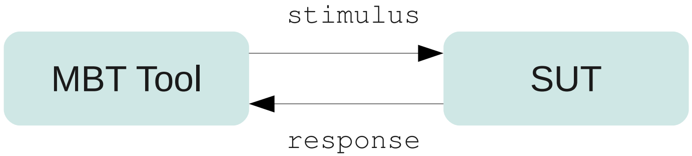

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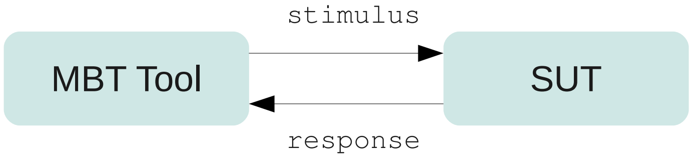

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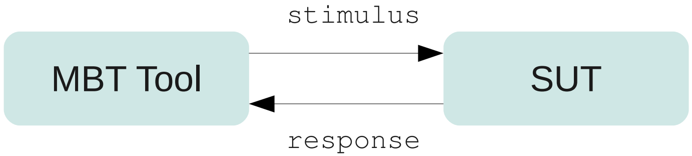

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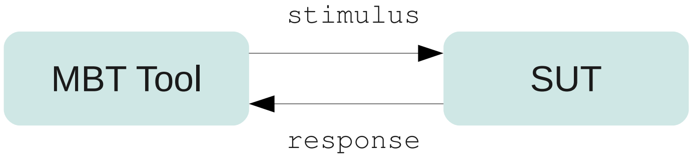
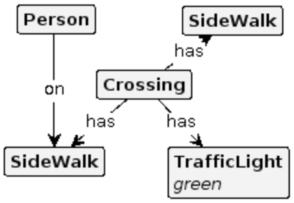


Graph Grammars (1/2)



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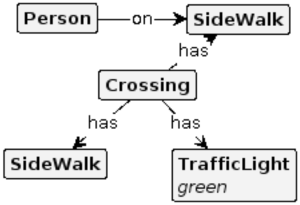
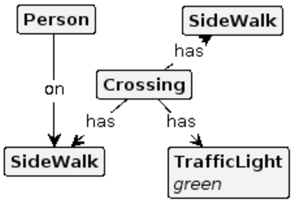


after

- Graphs represent system states

Graph Grammars (1/2)



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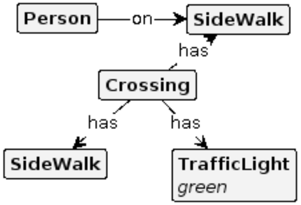

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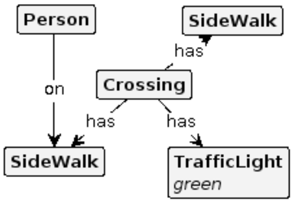
- Graphs represent system states
- Graph rules express possible changes to graph

Graph Grammars (1/2)



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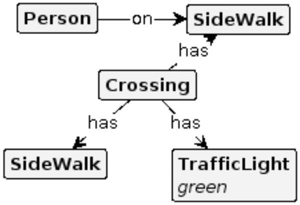
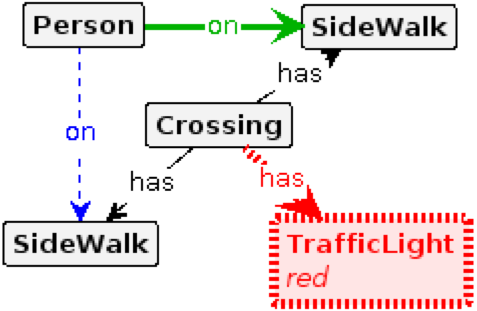


after

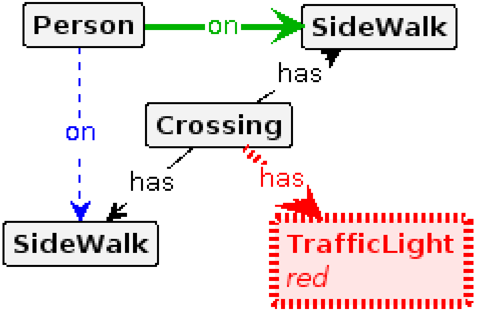
- Graphs represent system states
- Graph rules express possible changes to graph
- All possible changes make a *Graph Transition System*

Graph Grammars (2/2)



- Black and blue parts have to be present in graph

Graph Grammars (2/2)



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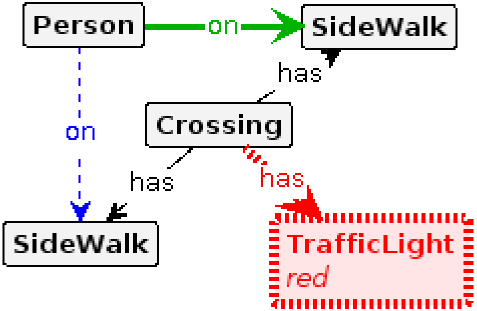
Graph Grammars (2/2)



- Black and blue parts have to be present in graph
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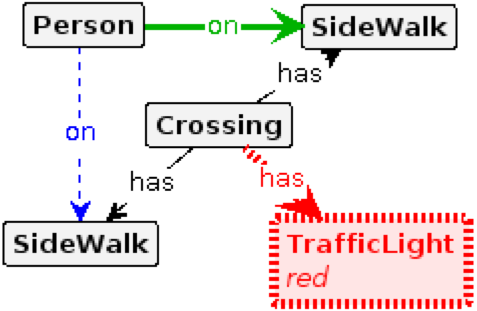
- Blue is erased from graph

Graph Grammars (2/2)



- Black and blue parts have to be present in graph
- Red parts may not be present in graph
- Blue is erased from graph
- Green is added to graph

Tools

- Axini Test Manager (ATM)

Tools

- Axini Test Manager (ATM)
- GRaphs for Object-Oriented VErification (GROOVE)

Research Goals

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  - Use GROOVE and ATM to create model-based testing tool with Graph Grammars

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Research Goals

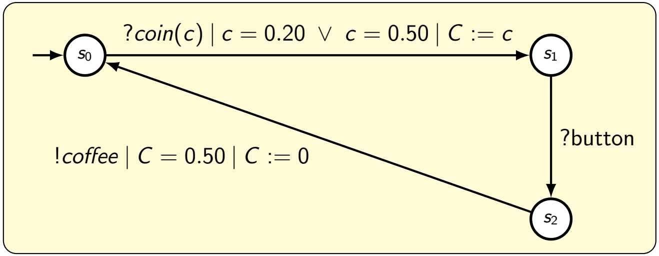
- Goals
  - Use GROOVE and ATM to create model-based testing tool with Graph Grammars
  - Validate this tool using case studies
- Motivation
  - Graphs are well-known and often used to represent system states
  - Rules are useful for describing computations

Inhoudsopgave

Inhoudsopgave

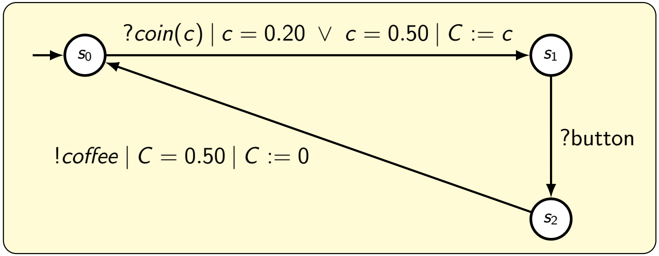
Setup (1/2)

- Graphs for humans, transition systems for computers


$$\begin{tikzcd}
\arrow[r] & s_0 \arrow[rr, "?coin(c) \mid c = 0.20 \vee c = 0.50 \mid C := c"] & & s_1 \arrow[d, "?button"] \\
& & & s_2 \arrow[ull, "!coffee \mid C = 0.50 \mid C := 0"]
\end{tikzcd}$$

Setup (1/2)

- Graphs for humans, transition systems for computers
- ATM uses *Symbolic Transition Systems*



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Setup (2/2)

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  1. creates STS from the GG in GROOVE

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Setup (2/2)

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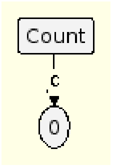
- Step number 1 main part of this research.

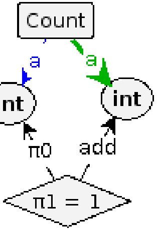
Inhoudsopgave

Algorithm

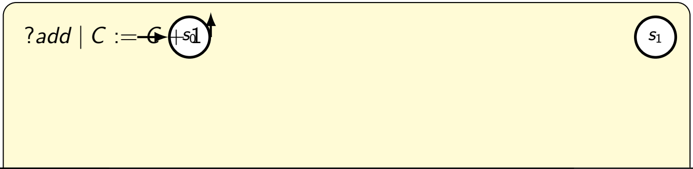
1. Create variables from data values



graph

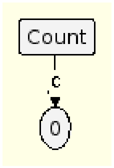


rule



Algorithm

1. Create variables from data values
2. Explore GTS disregarding data values



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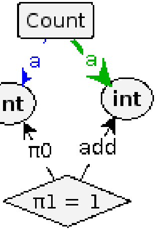

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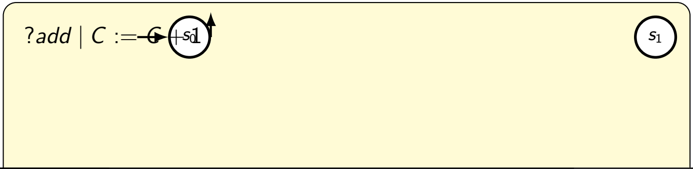
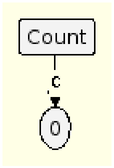


Algorithm

1. Create variables from data values
2. Explore GTS disregarding data values
3. Parse guards and updates from rules



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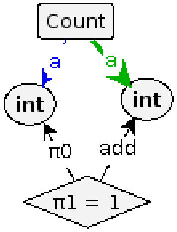

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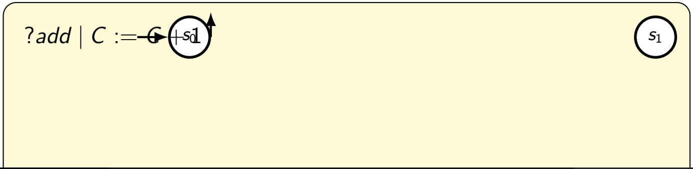

Constraints

1. Variables have to be unique

one picture here with all mistakes.

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2. Variables cannot be part of NACs

one picture here with all mistakes.

Constraints

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2. Variables cannot be part of NACs
3. Structural constraints on node creating rules

one picture here with all mistakes.

Inhoudsopgave

Model Examples

- 4 small examples used:

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  1. a boardgame

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Model Examples

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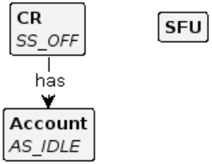
  3. a reservation system
  4. a bar tab system

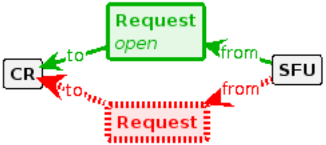
Case study (1/2)

- Self-checkout register

Case study (2/2)



graph



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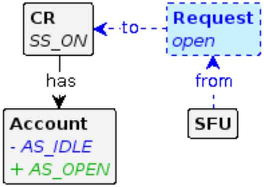

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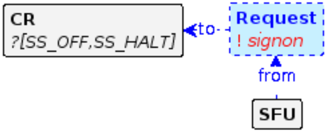

error

Inhoudsopgave

Conclusion

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- Transformation needs to be extended: complex data structures

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- Transformation needs to be extended: complex data structures
- Modelling behavior with GGs is effective